DOCUMENT RESUME

ED 428 975 SE 062 406

TITLE	Highlights from TIMSS: Overview and Key Findings across Grade Levels.
INSTITUTION	National Center for Education Statistics (ED), Washington, DC.
REPORT NO	NCES-1999-081
PUB DATE	1999-00-00
NOTE	14p.
AVAILABLE FROM	Tel: 202-219-1333; Web site: http://nces.ed.gov/timss
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Achievement Tests; *Cross Cultural Studies; Elementary Secondary Education; Foreign Countries; *International Studies; *Mathematics Achievement; Mathematics Education; Science Education
IDENTIFIERS	*Science Achievement; *Third International Mathematics and Science Study

ABSTRACT

This booklet provides an overview of the Third International Mathematics and Science Study (TIMSS). Key findings from the Pursuing Excellence series of reports for each grade level as well as overall comparative findings are detailed. At the fourth grade level, U.S. students were above the international average in both science and mathematics. In the eighth grade, U.S. students scored above the international average in science and below the international average in mathematics. At the end of secondary schooling, U.S. performance was among the lowest in both science and mathematics. (ASK)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 428 975

Highlights from TIMSS: Overview and Key Findings across Grade Levels

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☒ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

SE 062 406

BEST COPY AVAILABLE

HIGHLIGHTS FROM TIMSS

THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

Overview and Key Findings Across Grade Levels

With information on a half-million students worldwide, including more than 33,000 U.S. students in more than 500 U.S. public and private schools, the Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international study of schools and students ever conducted. During the 1995 school year, students from 41 nations, including our country's major trading partners, were assessed at three different grade levels (fourth, eighth, and in the final year of secondary school) to compare their mathematics and science achievement.

TIMSS researchers also looked at schools, curricula, instruction, lessons, textbooks, policy issues, and the lives of teachers and students to understand the educational context in which mathematics and science learning take place. By combining multiple methodologies and scientific sampling procedures that go beyond simple student achievement score comparisons and questionnaires, TIMSS created a fair and comprehensive portrait of how U.S. mathematics and science education differs from that of other nations. The richness of TIMSS includes a videotape study of eighth grade mathematics teaching, which observed 231 classrooms in Japan, Germany, and the United States, and an analysis of over 1,100 textbooks and curriculum frameworks from about 50 countries.

At the fourth grade, U.S. students were above the international average in both science and mathematics. In the eighth grade, U.S. students scored above the international average in science and below the international average in mathematics. At the end of secondary schooling (twelfth grade in the U.S.), U.S. performance was among the lowest in both science and mathematics, including among our most advanced students.

Because precise scores cannot be determined with perfect accuracy, it is not appropriate to compare U.S. scores to other countries by rank alone. Therefore, nations have been grouped into bands in the figures that follow, according to whether their performance is significantly higher than, not significantly different from, or significantly lower than the U.S.

Key findings from the *Pursuing Excellence* series of reports for each grade level, as well as overall comparative findings, are detailed inside.

OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT, U.S. DEPARTMENT OF EDUCATION NCES 1999-081

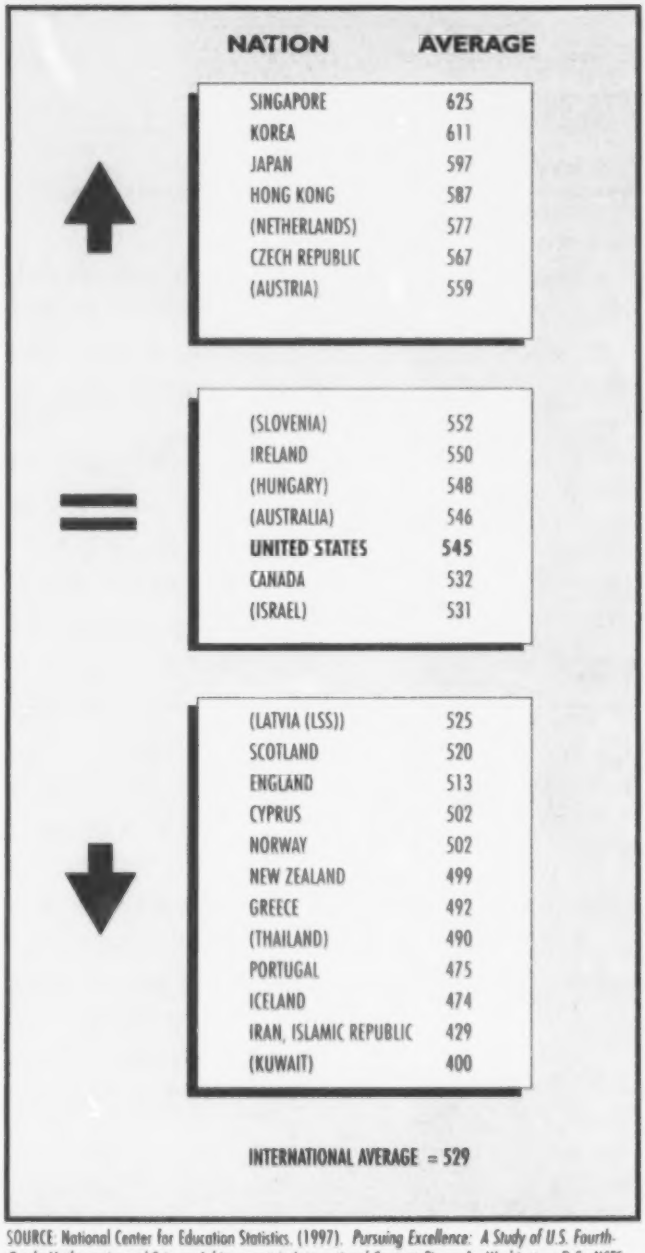
Fourth Grade

Achievement

- Among the 26 participating nations at this grade level, U.S. students scored above the international average in mathematics, and were outperformed by 7 countries (Figure 1).
- In science, U.S. students were outperformed by one country, Korea (Figure 2).
- In mathematics, U.S. students' performance exceeded the international average in Whole Numbers; Fractions and Proportionality; Data Representation, Analysis and Probability; Geometry; and Patterns, Relations and Functions. Our students were below the international average in Measurement, Estimation, and Number Sense.
- In science, U.S. fourth-grade students were outperformed by one or two other nations in Earth Science; Life Science; and Environmental Issues and the Nature of Science. In Physical Science, U.S. students were outperformed by 5 other nations.
- If an international talent search were to select the top 10 percent of all fourth graders, 9 percent of U.S. fourth graders would be included in mathematics, and 16 percent would be included in science.

FIGURE 1–GRADE 4

NATIONS' AVERAGE MATHEMATICS PERFORMANCE COMPARED WITH THE U.S.



SOURCE: National Center for Education Statistics. (1997). *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context.* Figure 1. Washington, D.C.: NCES.

NOTES:
1. Nations not meeting international guidelines are shown in parentheses.
2. Latvia is designated LSS because only Latvian-speaking schools were tested.
3. The international average is the average of the national averages of the 26 nations.

▲ Nations with average scores significantly higher than the U.S.

= Nations with average scores not significantly different from the U.S.

▼ Nations with average scores significantly lower than the U.S.

FIGURE 2–GRADE 4

NATIONS' AVERAGE SCIENCE PERFORMANCE COMPARED WITH THE U.S.

	NATION	AVERAGE
▲	KOREA	597
=	JAPAN	574
=	**UNITED STATES**	**565**
=	(AUSTRIA)	565
=	(AUSTRALIA)	562
=	(NETHERLANDS)	557
=	CZECH REPUBLIC	557
▼	ENGLAND	551
▼	CANADA	549
▼	SINGAPORE	547
▼	(SLOVENIA)	546
▼	IRELAND	539
▼	SCOTLAND	536
▼	HONG KONG	533
▼	(HUNGARY)	532
▼	NEW ZEALAND	531
▼	NORWAY	530
▼	(LATVIA (LSS))	512
▼	(ISRAEL)	505
▼	ICELAND	505
▼	GREECE	497
▼	PORTUGAL	480
▼	CYPRUS	475
▼	(THAILAND)	473
▼	IRAN, ISLAMIC REPUBLIC	416
▼	(KUWAIT)	401

INTERNATIONAL AVERAGE = 524

SOURCE: National Center for Education Statistics. (1997). *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*. Figure 2. Washington, D.C.: NCES.

NOTES:
1. Nations not meeting international guidelines are shown in parentheses.
2. Latvia is designated LSS because only Latvian-speaking schools were tested.
3. The international average is the average of the national averages of the 26 nations.

▲ Nations with average scores significantly higher than the U.S.

= Nations with average scores not significantly different from the U.S.

▼ Nations with average scores significantly lower than the U.S.

Curriculum

- The number of topics included in U.S. textbooks and curriculum guides was above the international average in fourth-grade mathematics and somewhat below the international average in fourth-grade science.

Achievement

- U.S. students scored below the international average of 41 nations in mathematics (Figure 3).
- U.S. students scored above the international average in science (Figure 4).
- In mathematics, U.S. students scored at about the international average in Data Representation, Analysis and Probability; Algebra; and Fractions and Number Sense; and below the international average in Geometry; Measurement; and Proportionality.
- In science, U.S. students scored above the international average in Earth Science; Life Science; and Environmental Issues and the Nature of Science. They scored at the international average in Chemistry and in Physics.
- If an international talent search were to select the top 10 percent of all eighth graders, 5 percent of U.S. eighth graders would be included in mathematics, and 13 percent would be included in science.

FIGURE 3–GRADE 8

NATIONS' AVERAGE MATHEMATICS PERFORMANCE COMPARED WITH THE U.S.

	NATION	AVERAGE
▲	SINGAPORE	643
▲	KOREA	607
▲	JAPAN	605
▲	HONG KONG	588
▲	BELGIUM-FLEMISH	565
▲	CZECH REPUBLIC	564
▲	SLOVAK REPUBLIC	547
▲	SWITZERLAND	545
▲	(NETHERLANDS)	541
▲	(SLOVENIA)	541
▲	(BULGARIA)	540
▲	(AUSTRIA)	539
▲	FRANCE	538
▲	HUNGARY	537
▲	RUSSIAN FEDERATION	535
▲	(AUSTRALIA)	530
▲	IRELAND	527
▲	CANADA	527
▲	(BELGIUM-FRENCH)	526
▲	SWEDEN	519
=	(THAILAND)	522
=	(ISRAEL)	522
=	(GERMANY)	509
=	NEW ZEALAND	508
=	ENGLAND	506
=	NORWAY	503
=	(DENMARK)	502
=	**UNITED STATES**	**500**
=	(SCOTLAND)	498
=	LATVIA(LSS)	493
=	SPAIN	487
=	ICELAND	487
=	(GREECE)	484
=	(ROMANIA)	482
▼	LITHUANIA	477
▼	CYPRUS	474
▼	PORTUGAL	454
▼	IRAN, ISLAMIC REPUBLIC	428
▼	(KUWAIT)	392
▼	(COLOMBIA)	385
▼	(SOUTH AFRICA)	354

INTERNATIONAL AVERAGE = 513

SOURCE: National Center for Education Statistics. (1996). *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context.* Figure 1. Washington, D.C.: NCES.

NOTES:
1. Nations not meeting international guidelines are shown in parentheses.
2. Latvia is designated LSS because only Latvian-speaking schools were tested.
3. The international average is the average of the national averages of the 41 nations.
4. The country average for Sweden may appear to be out of place; however, statistically, its placement is correct.

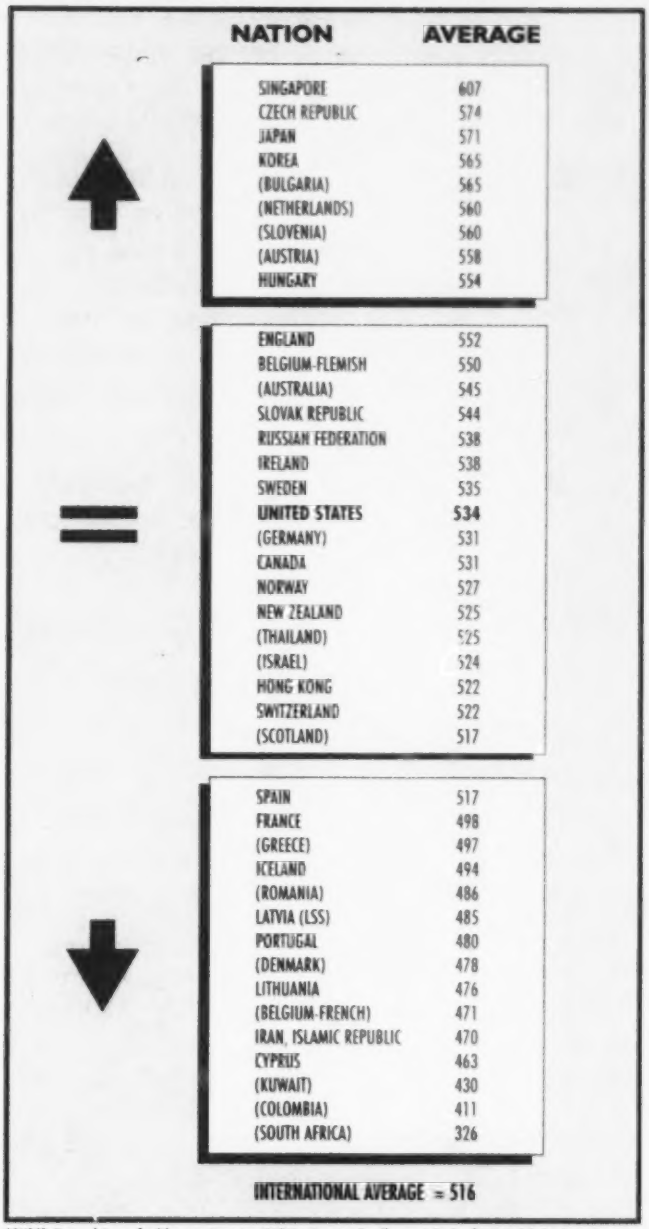
▲ Nations with average scores significantly higher than the U.S.

= Nations with average scores not significantly different from the U.S.

▼ Nations with average scores significantly lower than the U.S.

FIGURE 4–GRADE 8

NATIONS' AVERAGE SCIENCE PERFORMANCE COMPARED WITH THE U.S.



NATION	AVERAGE
SINGAPORE	607
CZECH REPUBLIC	574
JAPAN	571
KOREA	565
(BULGARIA)	565
(NETHERLANDS)	560
(SLOVENIA)	560
(AUSTRIA)	558
HUNGARY	554
ENGLAND	552
BELGIUM-FLEMISH	550
(AUSTRALIA)	545
SLOVAK REPUBLIC	544
RUSSIAN FEDERATION	538
IRELAND	538
SWEDEN	535
UNITED STATES	**534**
(GERMANY)	531
CANADA	531
NORWAY	527
NEW ZEALAND	525
(THAILAND)	525
(ISRAEL)	524
HONG KONG	522
SWITZERLAND	522
(SCOTLAND)	517
SPAIN	517
FRANCE	498
(GREECE)	497
ICELAND	494
(ROMANIA)	486
LATVIA (LSS)	485
PORTUGAL	480
(DENMARK)	478
LITHUANIA	476
(BELGIUM-FRENCH)	471
IRAN, ISLAMIC REPUBLIC	470
CYPRUS	463
(KUWAIT)	430
(COLOMBIA)	411
(SOUTH AFRICA)	326

INTERNATIONAL AVERAGE = 516

SOURCE: National Center for Education Statistics. (1996). *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context.* Figure 2. Washington, D.C.: NCES.

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Latvia is designated LSS because only Latvian-speaking schools were tested.
3. The international average is the average of the national averages of the 41 nations.
4. The country average for Scotland (or Spain) may appear to be out of place; however, statistically, its placement is correct.

▲ Nations with average scores significantly higher than the U.S.

= Nations with average scores not significantly different from the U.S.

▼ Nations with average scores significantly lower than the U.S.

Curriculum

- The U.S. eighth-grade mathematics curriculum is less focused than other countries based on an analysis of the intended curriculum in each of the 41 TIMSS countries. The U.S. eighth-grade science curriculum more closely reflects international practices.
- Compared to Germany and Japan, the U.S. eighth-grade mathematics curriculum appears less advanced based on the topics covered and the time devoted to each topic. The content being taught in U.S. eighth-grade mathematics classrooms is at about a seventh-grade level in comparison to other countries. However, the TIMSS study did not assess the level of advancement in the U.S. eighth-grade science curriculum.
- In the TIMSS videotapes of instructional practices, 40 percent of U.S. eighth-grade mathematics lessons included arithmetic topics such as whole number operations, fractions, and decimals, whereas these topics were much less common in Germany and Japan. In contrast, German and Japanese eighth-grade lessons were more likely to cover algebra and geometry.

Teaching

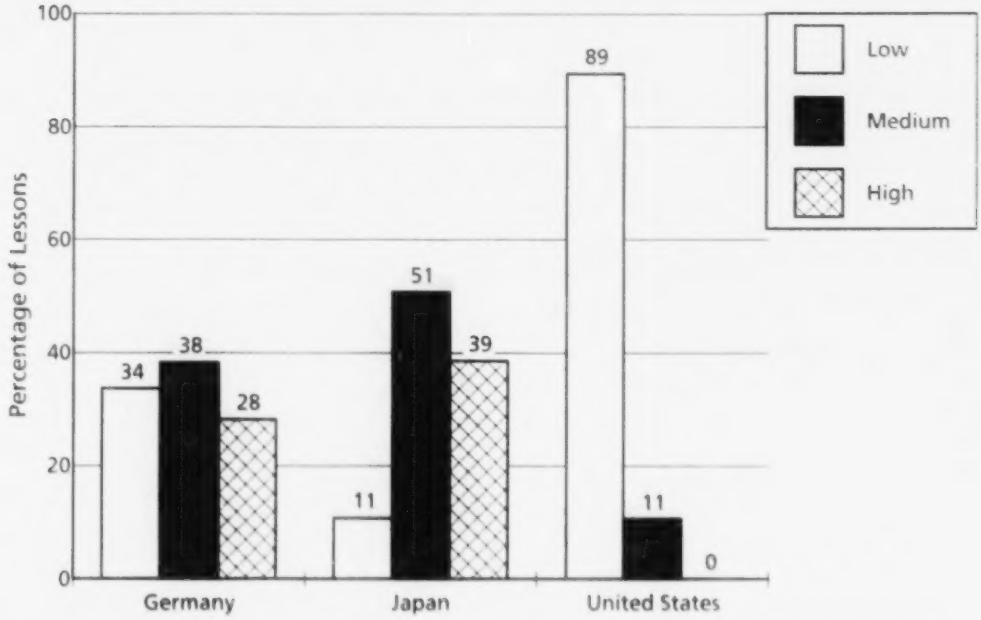
- Eighth-grade U.S. mathematics teachers' typical goal is to teach students how to do something, while Japanese teachers' goal is to help students learn how to do something and also understand mathematical concepts so that they can solve future problems.

BEST COPY AVAILABLE

- Ninety-five percent of U.S. teachers stated that they were either "very aware" or "somewhat aware" about current ideas in the teaching and learning of mathematics. However, in the videotape study only a few teachers were observed to apply the key concepts of current reform measures in their classrooms. The TIMSS findings suggest that Japanese rather than U.S. or German lessons more often resembled the recommendations of experts and the U.S. reform movement. U.S. lessons typically focused on acquiring mathematical skills rather than conceptual understanding, and were less coherently presented.
- Developing mathematical concepts – that is proving, deriving, or explaining in some detail – is rare among U.S. teachers in comparison to German and Japanese teachers. U.S. teachers rarely developed mathematical concepts, in contrast to German and Japanese teachers who usually did. The average percentage of topics that were developed was 22 percent in the U.S., whereas the average was 77 percent in Germany and 83 percent in Japan.
- In the judgment of independent mathematics and mathematics education experts, none of the U.S. lessons evaluated in the TIMSS videotape study was considered to contain a high-quality sequence of mathematical ideas, compared to 39 percent of Japanese lessons, and 28 percent of German lessons (Figure 5).
- New teachers in the U.S. receive less on-the-job training and mentoring than do new teachers in Japan and Germany.

FIGURE 5–GRADE 8

PERCENTAGE OF LESSONS RATED AS HAVING LOW, MEDIUM, AND HIGH QUALITY OF MATHEMATICAL CONTENT



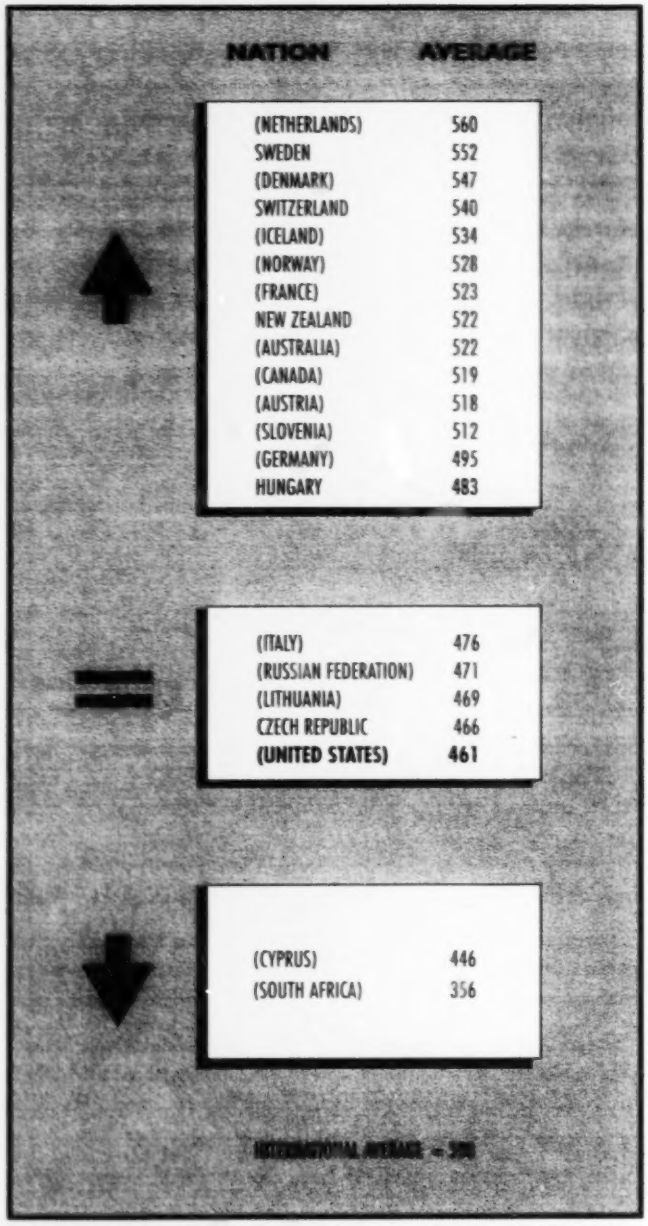
SOURCE: National Center for Education Statistics. (1999). *The TIMSS Videotape Classroom Study: Methods and Findings from an Exploratory Research Project on Eighth Grade Mathematics Instruction in Germany, Japan, and the United States.* Figure 34. Washington, D.C.: NCES.

Achievement of All Students

- A sample of all students at the end of secondary school (twelfth grade in the U.S.) was assessed in mathematics and science general knowledge. The mathematics and science general knowledge assessments were a test of the mathematics and science needed to function effectively in society as adults.
- The content of the mathematics general knowledge assessment represented about a seventh-grade level of curriculum for most TIMSS nations, but was most equivalent to the ninth-grade curriculum in the United States. The science general knowledge content was most equivalent to ninth-grade curriculum internationally, and to eleventh-grade curriculum in the United States.
- U.S. twelfth graders scored below the international average and among the lowest of the 21 participating nations in both mathematics and science general knowledge (Figures 6 and 7). The U.S. outperformed only South Africa and Cyprus on both assessments.
- The U.S. international standing on the general knowledge assessments of TIMSS was stronger in science than in mathematics.
- TIMSS is a fair and accurate comparison of mathematics and science achievement at the end of secondary schooling in the participating nations. The enrollment rate for secondary education in the U.S. is typical of other TIMSS countries, so our general population is not being compared to more select groups in other countries.

FIGURE 6–FINAL YEAR OF SECONDARY SCHOOL

NATIONS' AVERAGE MATHEMATICS GENERAL KNOWLEDGE PERFORMANCE COMPARED WITH THE U.S.



SOURCE: National Center for Education Statistics. (1998). *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*. Figure 1. Washington, D.C.: NCES.

NOTES:
1. Nations not meeting international guidelines are shown in parentheses.
2. The international average is the average of the national averages of the 21 nations.

▲ Nations with average scores significantly higher than the U.S.

= Nations with average scores not significantly different from the U.S.

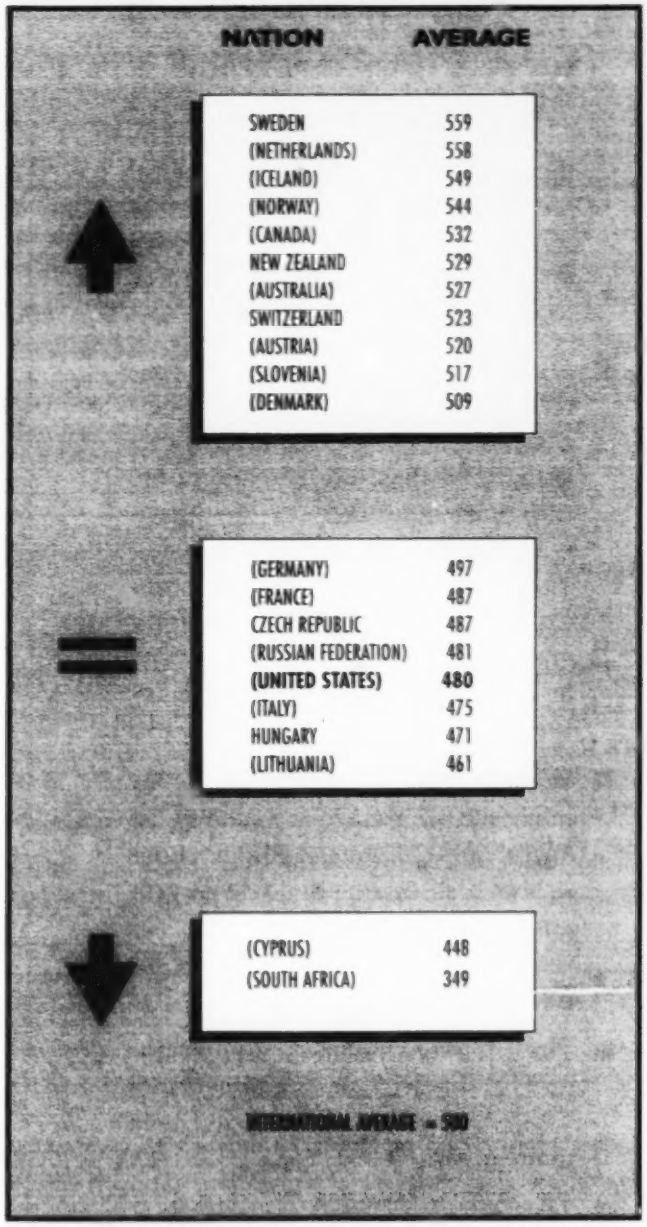
▼ Nations with average scores significantly lower than the U.S.

Final Year of Secondary School

- U.S. students in their final year of secondary school were less likely to be taking mathematics or science than were their counterparts in other countries. While 66 percent of graduating students in the U.S. were currently taking mathematics, the average in all the countries participating in the general knowledge assessments was 79 percent. The same pattern was also true for science (53 percent for the United States and 67 percent for all the TIMSS countries).

FIGURE 7–FINAL YEAR OF SECONDARY SCHOOL

NATIONS' AVERAGE SCIENCE GENERAL KNOWLEDGE PERFORMANCE COMPARED WITH THE U.S.



SOURCE: National Center for Education Statistics. (1998). *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context.* Figure 5. Washington, D.C.: NCES.

NOTES:
1. Nations not meeting international guidelines are shown in parentheses.
2. The international average is the average of the national averages of the 21 nations.

▲ Nations with average scores significantly higher than the U.S.

= Nations with average scores not significantly different from the U.S.

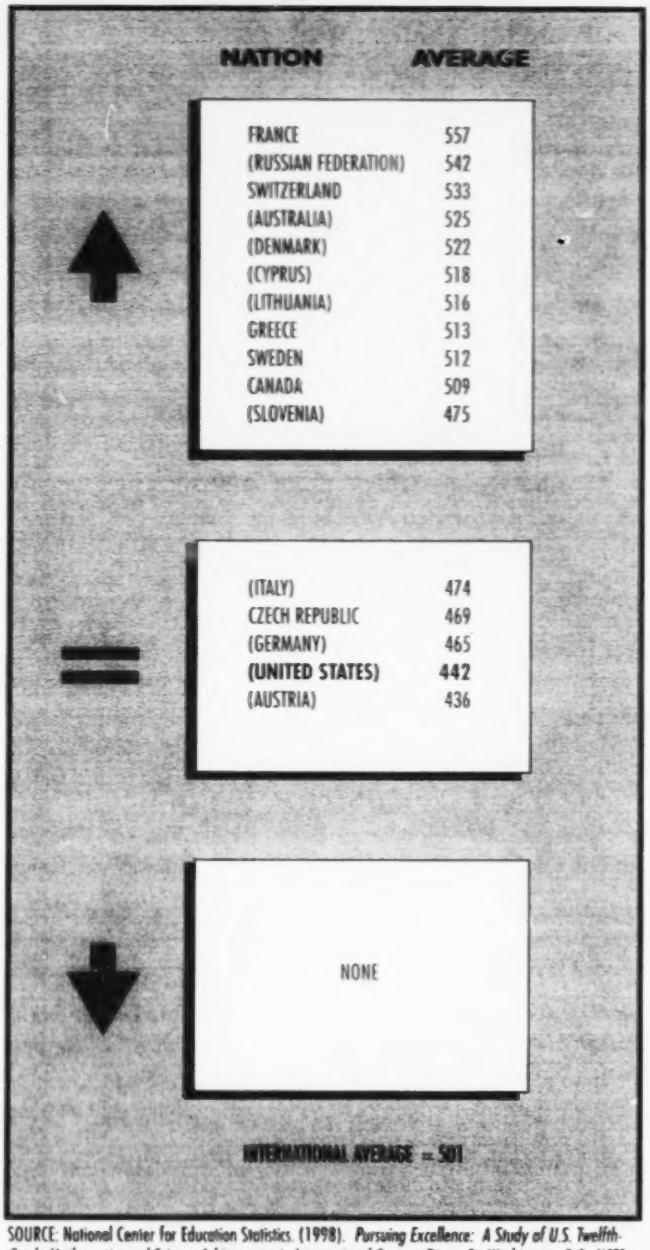
▼ Nations with average scores significantly lower than the U.S.

Achievement of Advanced Students

- The advanced mathematics and the physics assessments were administered to a sample of the top 10-20 percent of students in each of the 16 nations participating in these portions of TIMSS. In the advanced mathematics assessment, U.S. students who had taken or were taking pre-calculus, calculus, or AP calculus were compared to advanced mathematics students in other countries. In the physics assessment, U.S. students who had taken or were taking physics or AP physics were compared to advanced science students in other countries.
- The average scores of U.S. physics and advanced mathematics students were below the international average and among the lowest of the 16 countries that administered the physics and the advanced mathematics assessments (Figures 8 and 9). The U.S. outperformed no other country on either assessment.
- When one compares just U.S. twelfth graders with Advanced Placement calculus instruction to all advanced mathematics students in other nations, their performance was at the international average and significantly higher than 5 other countries.

FIGURE 8–FINAL YEAR OF SECONDARY SCHOOL

AVERAGE MATHEMATICS PERFORMANCE OF ADVANCED MATHEMATICS STUDENTS IN ALL COUNTRIES



SOURCE: National Center for Education Statistics. (1998). *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context.* Figure 9. Washington, D.C.: NCES.

NOTES:
1. Nations not meeting international guidelines are shown in parentheses.
2. The international average is the average of the national averages of the 16 nations.

▲ Nations with average scores significantly higher than the U.S.

= Nations with average scores not significantly different from the U.S.

▼ Nations with average scores significantly lower than the U.S.

Final Year of Secondary School

- When one compares just U.S. twelfth graders with Advanced Placement physics instruction to all advanced science students in other nations, their performance was below the international average and significantly higher than only 1 other country.
- More countries outperformed U.S. students in physics than in advanced mathematics (Figures 8 and 9). This differs from results for mathematics and science general knowledge, where more countries outperformed the U.S. in mathematics than in science.

FIGURE 9–FINAL YEAR OF SECONDARY SCHOOL

AVERAGE PHYSICS PERFORMANCE OF ADVANCED SCIENCE STUDENTS IN ALL COUNTRIES

NATION	AVERAGE
▲ NORWAY	581
▲ SWEDEN	573
▲ (RUSSIAN FEDERATION)	545
▲ (DENMARK)	534
▲ (SLOVENIA)	523
▲ (GERMANY)	522
▲ (AUSTRALIA)	518
▲ (CYPRUS)	494
▲ (LATVIA)	488
▲ SWITZERLAND	488
▲ GREECE	486
▲ (CANADA)	485
▲ FRANCE	466
▲ CZECH REPUBLIC	451
= (AUSTRIA)	435
= **(UNITED STATES)**	**423**
▼ NONE	

SOURCE: National Center for Education Statistics. (1998). *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context.* Figure 16. Washington, D.C.: NCES.

NOTES:
1. Nations not meeting international guidelines are shown in parentheses.
2. The international average is the average of the national averages of the 16 nations.

▲ Nations with average scores significantly higher than the U.S.

= Nations with average scores not significantly different from the U.S.

▼ Nations with average scores significantly lower than the U.S.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1999 — 450-617

Overall Comparative Findings

Achievement

- Our students' performance was stronger in science than in mathematics in fourth grade, in eighth grade, and in the twelfth-grade general knowledge assessment relative to the other countries participating in TIMSS.
- U.S. students' international standing was stronger at the fourth grade than at the eighth grade in both mathematics and science relative to the 25 other countries that participated in TIMSS at both grade levels.
- U.S. students' international standing was stronger at the eighth grade than at the twelfth grade in both mathematics and science relative to the international averages for the 19 other countries that participated in TIMSS at both levels.
- There was no significant gender gap in fourth-grade or eighth-grade mathematics achievement or eighth-grade science achievement in the U.S. The U.S. was one of ten countries, out of 26, with a gender gap favoring males in fourth-grade science achievement.
- There was no significant gender gap among U.S. twelfth-grade students on the mathematics general knowledge assessment. There was a gender gap favoring males among U.S. twelfth graders in science general knowledge, physics, and advanced mathematics.

Contexts of Learning

- The amount of homework does not appear to be related to U.S. performance compared to other nations. U.S. fourth graders are assigned about as much homework as students in other countries, U.S. eighth graders spend about as much time outside of school studying as students in Japan and Germany, all U.S. twelfth graders spend less time on homework, and U.S. advanced twelfth graders were assigned homework more often.
- The amount of instructional time does not appear to be related to U.S. performance compared to other TIMSS nations. U.S. fourth graders spend more class time on mathematics and science than do their average international counterparts. U.S. eighth graders spend more time in mathematics classes per year than students in Germany and Japan.
- The amount of television watching also does not appear to be strongly related to U.S. performance compared to other nations. Heavy television watching is as common among U.S. eighth graders as it is among their Japanese counterparts, and U.S. twelfth graders spend, on average, the same amount of time watching television or videos as the international average.
- Although U.S. twelfth-grade students are more likely to have jobs outside of school than their international counterparts and work longer hours, this does not appear to be related to the relatively poor U.S. performance on the final year of secondary school general knowledge assessments in comparison to their international counterparts.

Overall Comparative Findings

FIGURE 10–OVERALL COMPARATIVE FINDINGS

U.S. PERFORMANCE RELATIVE TO THE INTERNATIONAL AVERAGE AT A GLANCE

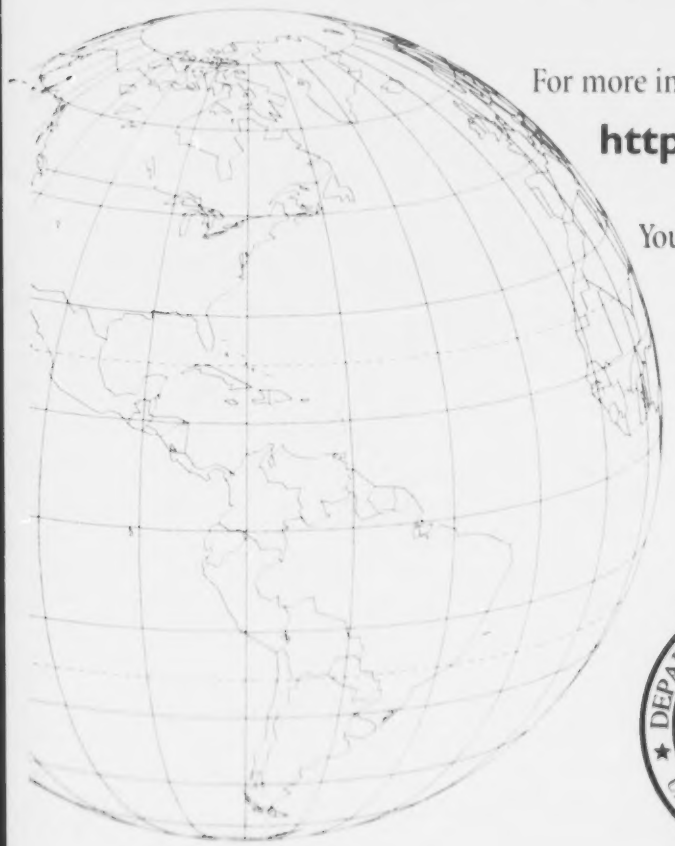
Content Area	Fourth Grade	Eighth Grade	Final Year of Secondary School	Advanced Math & Science Students
Mathematics Overall	Above	Below	Below	—
Science Overall	Above	Above	Below	—
Advanced Mathematics	—	—	—	Below
Physics	—	—	—	Below

SOURCES:

National Center for Education Statistics. (1997). *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*. Figure 1, Figure 2. Washington, D.C.: NCES.

National Center for Education Statistics. (1996). *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*. Figure 1, Figure 2. Washington, D.C.: NCES.

National Center for Education Statistics. (1998). *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*. Figure 1, Figure 5, Figure 9, Figure 16. Washington, D.C.: NCES.



For more information you can visit us on the World Wide Web:

http://nces.ed.gov/timss

You can also contact the TIMSS customer service number:

(202) 219-1333

or send e-mail to:

timss@ed.gov

MARCH 1999